Write your name here

| Surname | | Other names |
|---|---|---|
| | | |

Centre Number

Candidate Number

# Chemistry

**Unit: 4CH0**
**Paper: 2CR**

Monday 10 June 2013 – Afternoon
**Time: 1 hour**

Paper Reference

**4CH0/2CR**

**You must have:**
Ruler
Calculator

Total Marks

## Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided
  – *there may be more space than you need*.
- Show all the steps in any calculations and state the units.

## Information

- The total mark for this paper is 60.
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*

## Advice

- Read each question carefully before you start to answer it.
- Keep an eye on the time.
- Write your answers neatly and in good English.
- Try to answer every question.
- Check your answers if you have time at the end.

*Turn over*

**PEARSON**

P 4 3 3 1 8 A 0 1 1 6

# THE PERIODIC TABLE

**Group**

|  | 1 | 2 |  |  |  |  |  |  |  |  |  |  | 3 | 4 | 5 | 6 | 7 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Period** | | | | | | | | | | | | | | | | | | |
| **1** | | | | | | 1<br>**H**<br>Hydrogen<br>1 | | | | | | | | | | | | 4<br>**He**<br>Helium<br>2 |
| **2** | 7<br>**Li**<br>Lithium<br>3 | 9<br>**Be**<br>Beryllium<br>4 | | | | | | | | | | | 11<br>**B**<br>Boron<br>5 | 12<br>**C**<br>Carbon<br>6 | 14<br>**N**<br>Nitrogen<br>7 | 16<br>**O**<br>Oxygen<br>8 | 19<br>**F**<br>Fluorine<br>9 | 20<br>**Ne**<br>Neon<br>10 |
| **3** | 23<br>**Na**<br>Sodium<br>11 | 24<br>**Mg**<br>Magnesium<br>12 | | | | | | | | | | | 27<br>**Al**<br>Aluminium<br>13 | 28<br>**Si**<br>Silicon<br>14 | 31<br>**P**<br>Phosphorus<br>15 | 32<br>**S**<br>Sulfur<br>16 | 35.5<br>**Cl**<br>Chlorine<br>17 | 40<br>**Ar**<br>Argon<br>18 |
| **4** | 39<br>**K**<br>Potassium<br>19 | 40<br>**Ca**<br>Calcium<br>20 | 45<br>**Sc**<br>Scandium<br>21 | 48<br>**Ti**<br>Titanium<br>22 | 51<br>**V**<br>Vanadium<br>23 | 52<br>**Cr**<br>Chromium<br>24 | 55<br>**Mn**<br>Manganese<br>25 | 56<br>**Fe**<br>Iron<br>26 | 59<br>**Co**<br>Cobalt<br>27 | 59<br>**Ni**<br>Nickel<br>28 | 63.5<br>**Cu**<br>Copper<br>29 | 65<br>**Zn**<br>Zinc<br>30 | 70<br>**Ga**<br>Gallium<br>31 | 73<br>**Ge**<br>Germanium<br>32 | 75<br>**As**<br>Arsenic<br>33 | 79<br>**Se**<br>Selenium<br>34 | 80<br>**Br**<br>Bromine<br>35 | 84<br>**Kr**<br>Krypton<br>36 |
| **5** | 86<br>**Rb**<br>Rubidium<br>37 | 88<br>**Sr**<br>Strontium<br>38 | 89<br>**Y**<br>Yttrium<br>39 | 91<br>**Zr**<br>Zirconium<br>40 | 93<br>**Nb**<br>Niobium<br>41 | 96<br>**Mo**<br>Molybdenum<br>42 | 99<br>**Tc**<br>Technetium<br>43 | 101<br>**Ru**<br>Ruthenium<br>44 | 103<br>**Rh**<br>Rhodium<br>45 | 106<br>**Pd**<br>Palladium<br>46 | 108<br>**Ag**<br>Silver<br>47 | 112<br>**Cd**<br>Cadmium<br>48 | 115<br>**In**<br>Indium<br>49 | 119<br>**Sn**<br>Tin<br>50 | 122<br>**Sb**<br>Antimony<br>51 | 128<br>**Te**<br>Tellurium<br>52 | 127<br>**I**<br>Iodine<br>53 | 131<br>**Xe**<br>Xenon<br>54 |
| **6** | 133<br>**Cs**<br>Caesium<br>55 | 137<br>**Ba**<br>Barium<br>56 | 139<br>**La**<br>Lanthanum<br>57 | 179<br>**Hf**<br>Hafnium<br>72 | 181<br>**Ta**<br>Tantalum<br>73 | 184<br>**W**<br>Tungsten<br>74 | 186<br>**Re**<br>Rhenium<br>75 | 190<br>**Os**<br>Osmium<br>76 | 192<br>**Ir**<br>Iridium<br>77 | 195<br>**Pt**<br>Platinum<br>78 | 197<br>**Au**<br>Gold<br>79 | 201<br>**Hg**<br>Mercury<br>80 | 204<br>**Tl**<br>Thallium<br>81 | 207<br>**Pb**<br>Lead<br>82 | 209<br>**Bi**<br>Bismuth<br>83 | 210<br>**Po**<br>Polonium<br>84 | 210<br>**At**<br>Astatine<br>85 | 222<br>**Rn**<br>Radon<br>86 |
| **7** | 223<br>**Fr**<br>Francium<br>87 | 226<br>**Ra**<br>Radium<br>88 | 227<br>**Ac**<br>Actinium<br>89 | | | | | | | | | | | | | | | |

**Key**

Relative atomic mass
**Symbol**
Name
Atomic number

**Answer ALL questions.**

1  Use the Periodic Table on page 2 to help you answer this question.

Give the name or symbol of

(a) the element in group 3 and period 4.

(1)

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(b) an element in period 3 that is a good conductor of electricity.

(1)

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(c) the element in group 7 that is the most reactive.

(1)

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(d) the element in group 5 that is present in a molecule of ammonia.

(1)

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(e) an element with an atom containing 8 electrons in its outer shell.

(1)

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**(Total for Question 1 = 5 marks)**

**2** (a) The list shows some techniques used to separate mixtures.

    **A**      crystallisation

    **B**      filtration

    **C**      fractional distillation

    **D**      paper chromatography

    **E**      simple distillation

Complete the table to show the best method of obtaining each substance from the mixture.

In each case, choose one of the letters A, B, C, D or E. Each letter may be used once, more than once or not at all.

**(4)**

| Substance | Mixture | Letter |
|---|---|---|
| sand | sand and water | |
| solid copper(II) sulfate | aqueous copper(II) sulfate | |
| red food dye | mixture of food dyes | |
| kerosene | crude oil | |

(b) Gold occurs in ores, which are mixtures of gold and other substances. Several elements and compounds are used in the extraction of gold from its ores.

Each box below represents the substances present in one part of the extraction process.

Classify the contents of each box as a compound, an element or a mixture by writing your choice below each box.

**(3)**
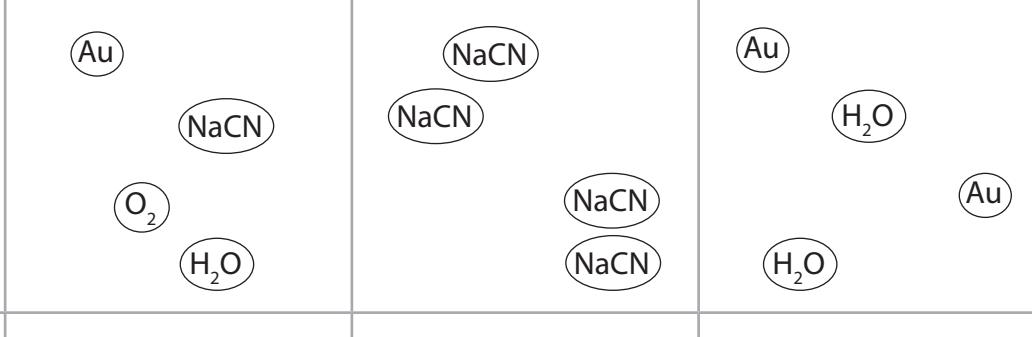
| | | | |
|---|---|---|---|
| | (Au) (NaCN) (O$_2$) (H$_2$O) | (NaCN) (NaCN) (NaCN) (NaCN) | (Au) (H$_2$O) (Au) (H$_2$O) |
| **Compound, element or mixture** | | | |

**(Total for Question 2 = 7 marks)**

**3** A student added some pieces of iron to a boiling tube containing dilute hydrochloric acid. She observed fizzing and the formation of a solution, X.

(a) Identify the gas that causes the fizzing and describe a test for it.

**(2)**

Gas ....................................................................................................................................................................................................

Test ....................................................................................................................................................................................................

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(b) Solution X contains chloride ions.

(i) The student confirmed this by adding some silver nitrate solution. She observed a white precipitate of silver chloride.

Give the formula of the white precipitate, and name the other solution she should have added before the silver nitrate solution.

**(2)**

Formula of white precipitate ....................................................................................................................................................

Other solution ....................................................................................................................................................................................

(ii) Complete the word equation for the reaction in this test.

**(1)**

iron chloride + silver nitrate → silver chloride + ..................................................................

(c) Solution X also contains ions of iron. The student thought that these ions had the formula $Fe^{2+}$ or $Fe^{3+}$.

What reagent should she add to decide whether solution X contains $Fe^{2+}$ or $Fe^{3+}$ ions? State the result of the test in each case.

**(3)**

Reagent ....................................................................................................................................................................................................

Result with $Fe^{2+}$ ions ..........................................................................................................................................................................

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Result with $Fe^{3+}$ ions ..........................................................................................................................................................................

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**(Total for Question 3 = 8 marks)**

**4** A teacher added some of the Group 1 elements to separate samples of water.

(a) State two observations that could be made when a small piece of sodium is added to a large trough containing water.

**(2)**

1 ..................................................................................................................................................................

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2 ..................................................................................................................................................................

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(b) In another experiment she added a small piece of a different Group 1 element and noticed that the reaction was less vigorous.

Which element did she add in this experiment?

**(1)**

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(c) In another experiment she added a small piece of potassium to a large trough containing water. This time she observed a lilac flame.

(i) Identify the gas that burned.

**(1)**

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(ii) Give the formula of the ion that caused the flame to be lilac.

**(1)**

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(d) When the Group 1 elements react with water, each of their atoms loses an electron from its outer shell. For sodium and potassium, these processes can be represented by the equations

- $Na \rightarrow Na^+ + e^-$
- $K \rightarrow K^+ + e^-$

Explain, by referring to the electronic configurations of sodium and potassium, why potassium is more reactive than sodium.

(4)

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**(Total for Question 4 = 9 marks)**

**5** Fractional distillation and cracking are important steps in processing crude oil.

(a) Place ticks (✓) in the columns to show which statements apply to each step.
You may place a tick in one column, in both columns or in neither column.

The first one has been done for you.

**(5)**

| Statement | Fractional distillation | Cracking |
|---|---|---|
| Crude oil is heated | ✓ | |
| A catalyst may be used | | |
| Alkenes are formed | | |
| Decomposition reactions occur | | |
| Fuels are obtained | | |
| Separation is the main purpose | | |

(b) The formula $CH_3CH_2CH_2CH_2CH_3$ represents one of the compounds in crude oil.

(i) Give the molecular formula of this compound.

**(1)**

(ii) Give the displayed formula of this compound.

**(1)**

(iii) Give the empirical formula of this compound.

**(1)**

(iv) Give the name of this compound.

**(1)**

(v) Give the general formula of the homologous series that contains this compound.

**(1)**

(c) The products of the complete combustion of hydrocarbons are carbon dioxide and water.

   (i) Balance the equation to show the complete combustion of ethene ($C_2H_4$).

   **(2)**

$$C_2H_4 \ + \ ................O_2 \ \rightarrow \ ................CO_2 \ + \ ................H_2O$$

   (ii) Draw a dot and cross diagram to show the bonding in an ethene molecule.

   Show only the outer electrons in each atom.

   **(2)**

(d) Ethanol can be manufactured by the hydration of ethene. The equation for this reaction is

$$C_2H_4(g) + H_2O(g) \rightarrow C_2H_5OH(g)$$
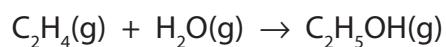
(i) Identify the catalyst and state the temperature used in this process.

(2)

Catalyst.................................................................................................................................................................................

Temperature........................................................................................................................................................................

(ii) A 20 mol sample of ethanol was produced using this reaction.

Deduce the amount, in moles, of ethene needed and the volume, in $dm^3$, that this amount of ethene would occupy at room temperature and pressure.

Assume that all of the ethene is converted into ethanol and that the molar volume of ethene is 24 $dm^3$ at rtp.

(3)

Amount of ethene ................................................................................................................................ mol

Volume of ethene

Volume = ........................................ $dm^3$

**(Total for Question 5 = 19 marks)**

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**6** Most experiments involving electrolysis use inert electrodes, which do not take part in the reactions. However, in some experiments the electrodes do take part in the reactions.

A student investigates the electrolysis of copper(II) sulfate solution using copper electrodes which do take part in the reaction. She uses this apparatus.
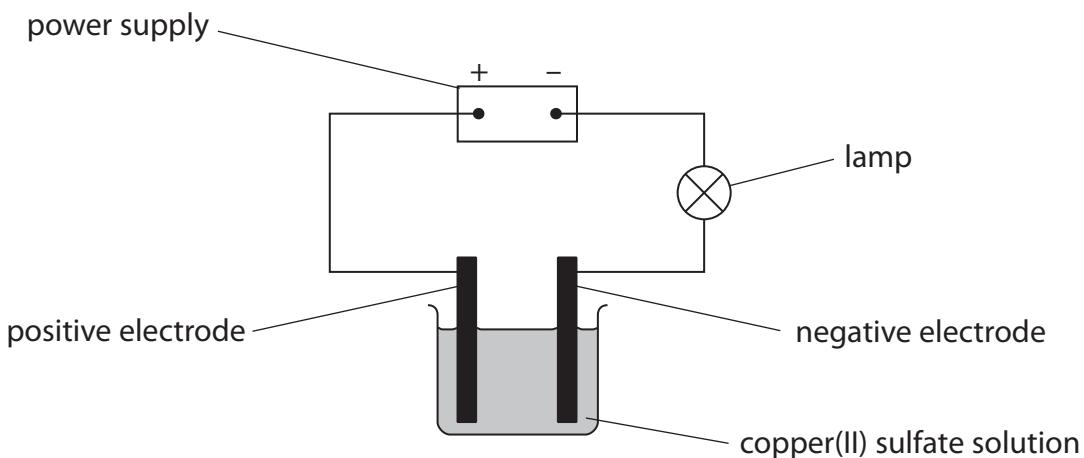


She uses this method.

- weigh two clean strips of copper

- use one strip as the positive electrode and the other as the negative electrode

- after electrolysis wash the strips of copper with ethanol (a liquid that boils at 78°C)

- dry the strips of copper and reweigh them

The ionic half-equations for the reactions at the electrodes are

Positive electrode $\quad$ $Cu(s) - 2e^- \rightarrow Cu^{2+}(aq)$

Negative electrode $\quad$ $Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$

(a) Suggest why the copper strips would dry more quickly when washed with ethanol rather than with water.

(1)

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*P 4 3 3 1 8 A 0 1 2 1 6*

(b) The student's results are shown in the table.

| | Positive electrode | Negative electrode |
|---|---|---|
| Mass of electrode before electrolysis in g | 8.78 | 7.95 |
| Mass of electrode after electrolysis in g | 8.46 | 8.25 |

The table shows that the decrease in mass of the positive electrode was 0.32 g.

(i) Calculate the increase in mass, in grams, of the negative electrode.

(1)

Increase in mass = ...................................... g

(ii) The ionic half-equations show that the increase in mass of the negative electrode should be the same as the decrease in mass of the positive electrode.

Suggest two reasons why the increase in mass of the negative electrode in the student's experiment was less than expected.

(2)

1 ....................................................................................................................................................................................

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2 ....................................................................................................................................................................................

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(c) Another student investigated the effect of changing the electrical charge, in faradays, passed during the electrolysis.

He wanted to find how this affected the increase in mass of the negative electrode.

One faraday is the electrical charge of one mole of electrons.

His results are shown in the table.

| Experiment | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| Electrical charge in faradays | 0.10 | 0.15 | 0.20 | 0.25 | 0.30 | 0.35 | 0.40 | 0.45 | 0.50 |
| Increase in mass in g | 3.20 | 4.80 | 7.40 | 8.00 | 9.60 | 11.20 | 12.80 | 14.40 | 16.00 |

(i) On the grid, plot a graph of increase in mass against electrical charge.

Draw a straight line of best fit. Start your line at the origin (0,0).

**(3)**

Increase in mass in g

Electrical charge in faradays
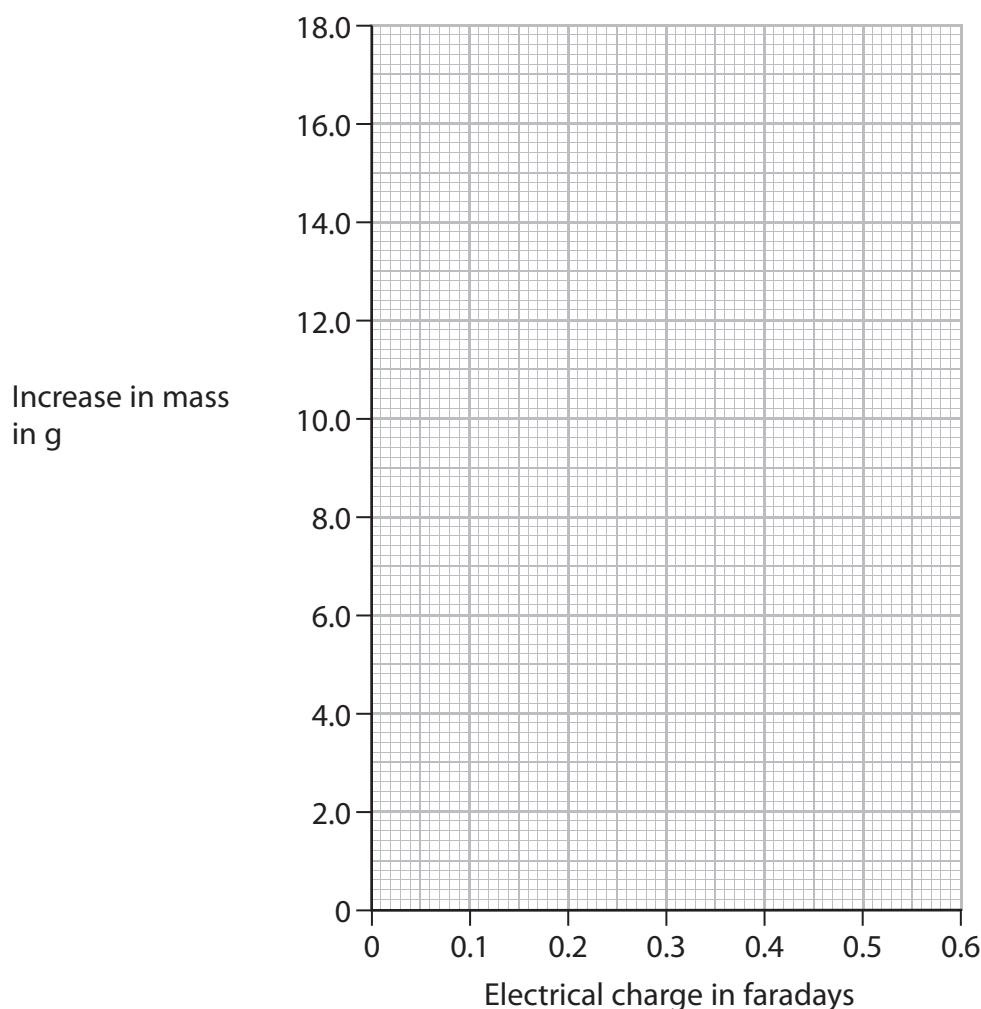
(ii) Draw a circle around the anomalous result.

**(1)**

(iii) Suggest why the straight line should go through the origin.

**(1)**

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(iv) Explain why the graph shows that the increase in mass is directly proportional to the electrical charge passed.

**(1)**

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(v) Use your graph to estimate the increase in mass, in grams, of the copper electrode that would be produced by passing an electrical charge of 0.55 faradays.

**(2)**

Increase in mass = ................................................................g

**(Total for Question 6 = 12 marks)**

**TOTAL FOR PAPER = 60 MARKS**

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